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Original Article

Correlation Between the Grade of Hydronephrosis with Surgical Outcomes After Ultrasound-guided Supine Percutaneous Nephrolithotomy: A Retrospective Observational Study

Supin Pozisyonda Ultrason Kılavuzluğunda Perkütan Nefrolitotomi Sonrası Hidronefroz Derecesi ile Cerrahi Sonuçlar Arasındaki İlişki: Retrospektif Bir Gözlemsel Çalışma

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ABSTRACT

Objective: The preferred therapy for staghorn stones and large kidney stones is percutaneous nephrolithotomy (PCNL). Ultrasound-guided PCNL has definite advantages over fluoroscopy-guided PCNL. Preoperative characteristics are essential to assess better surgical outcomes. The goal of this study was to analyze the correlation of hydronephrosis with surgical outcomes after ultrasound-guided supine PCNL.

Methods: A retrospective study was conducted at Doris Sylvanus General Hospital. Data of the patients was obtained from hospital records. Hundred and five patients underwent ultrasound-guided PCNL in the supine position from August 2020 to August 2022. Data were analyzed using SPSS 16.0.

Results: The presence of hydronephrosis was 85 (80.95%), which consisted of Grade I 15 (14.30%), Grade II 25 (23.80%), Grade III 28 (26.70%), and Grade IV 17 (16.20%). In our study analysis, complications occurred in 16 patients (15.23%). Grade I complications of the Clavien-Dindo classification was of in 4 cases, 11 cases of grade 2 complications, and 1 patient died. The statistical result was the relationship between grade hydronephrosis and the grade of complication using the modified Clavien-Dindo system. We found a p-value of 0.207 (>0.05), and there is no statistically significant relationship p=0.382 and r=-0.086 was a negative correlation. There is also no statistically significant relationship between hydronephrosis and stone clearance with p=0.310.

Conclusions: The use of ultrasonographic guidance PCNL has been reported as a safe and effective procedure for the management of

ÖZ

Amaç: Geyik boynuzu (staghorn) taşları ve büyük böbrek taşları için tercih edilen tedavi perkütan nefrolitotomidir (PCNL). Ultrason eşliğinde PCNL'nin floroskopi eşliğinde PCNL'ye göre bazı avantajları vardır. Preoperatif özellikler daha iyi cerrahi sonuçları değerlendirmek için çok önemlidir. Bu çalışmanın amacı, hidronefrozun supin pozisyonunda ultrason kılavuzluğunda PCNL sonrası cerrahi sonuçlarla ilişkisini analiz etmektir.

Yöntemler: Doris Sylvanus General Hospital'da retrospektif bir çalışma yapıldı. Hastaların bilgileri hastane kayıtlarından elde edildi. Ağustos 2020'den Ağustos 2022'ye kadar 105 hastaya supin pozisyonda ultrason kılavuzluğunda PCNL uygulandı. Veriler SPSS 16.0 kullanılarak analiz edildi.

Bulgular: Hidronefroz varlığı Evre I 15 (%14,30), Evre II 25 (%23,80), Evre III 28 (%26,70) ve Evre IV 17 (%16,20) olmak üzere 85 (%80,95) hastada görüldü. Çalışma analizimizde 16 hastada (%15,23) komplikasyon gelişti. Clavien-Dindo sınıflamasına göre 1. derece komplikasyon 4 olguda, 11 olguda 2. derece komplikasyon görüldü ve 1 hasta öldü. İstatistiksel sonuç, modifiye Clavien-Dindo sistemine göre komplikasyon derecesi ile hidronefroz derecesi arasındaki ilişkiydi. P-değerini 0,207 (>0,05) olarak bulduk, istatistiksel olarak anlamlı bir ilişki yoktu (p=0,382), ve r=-0,086 negatif korelasyon gösterdi. Ayrıca hidronefroz ile taş kleransı arasında istatistiksel olarak anlamlı bir ilişki bulunmadı (p=0,310).

Sonuçlar: Ultrason kılavuzluğunda PCNL kullanımı, büyük böbrek taşlarının tedavisi için güvenli ve etkili bir prosedür olarak bildirilmiştir.

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large renal stones. In this study, there was no correlation or signification between hydronephrosis and surgical outcome after ultrasound-guided supine PCNL.

Keywords: Hydronephrosis, outcome, percutaneous nephrolithotomy, ultrasonography, nephrolithiasis

Bu çalışmada, supin pozisyonda ultrason kılavuzluğunda PCNL sonrası cerrahi sonuç ile hidronefroz arasında bir ilişki ve anlamlılık gösterilmemiştir.

Anahtar kelimeler: Hidronefroz, sonuç, perkütan nefrolitotomi, ultrasonografi, nefrolitiazis

INTRODUCTION

The preferred therapy for staghorn stones and large kidney stones is percutaneous nephrolithotomy (PCNL)[1,2]. It is typically guided by fluoroscopy and could be radiation-risky, particularly in a high-workload facility. The adverse effects of X-rays, including genetic mutations and carcinogenesis, are not necessarily dose-dependent[1,3]. Fluoroscopy-guided PCNL cannot compete with the advantages of ultrasound-guided PCNL. It allows continuous real-time control during puncture with accurate placement of radiolucent stones without the requirement for intravenous or retrograde injection of contrast dye or radiation exposure of the surgical or theater crew[4,5].

Hydronephrosis is characterized as the dilatation of the pelvicalyceal system due to the failure of urine excretion. It is mainly sub-grouped into obstructive or non-obstructive hydronephrosis[3]. Urinary stones, blood clots, strictures, obstructions at the ureteropelvic junction, tumors, fibrosis, and other conditions are the usual causes of obstructive hydronephrosis. On the other hand, reflux, residual, or other factors can lead to non-obstructive hydronephrosis[4]. Hydronephrosis as a risk factor for complications following PCNL is not well studied. After PCNL, there is some debate over the impact of hydronephrosis on surgical results. For example, hydronephrosis is associated with a low number of complications after PCNL and on the other hand is associated with a higher residual stone[6,7]. Following PCNL, urosepsis has been noted as a frequent infection-related consequence. Most of the time, urosepsis goes undiagnosed and untreated. It is connected to urinary tract infections, which account for 5% of all kinds of sepsis[8]. According to new recommendations, urosepsis is a medical emergency that requires urgent treatment with the administration of appropriate intravenous antibiotics and intravenous fluids to control the hemodynamic state[9].

In 0-20% of patients, bleeding during PCNL is a serious consequence. Numerous studies have attempted to assess the potential causes of bleeding. The primary risk factor for bleeding during surgery is whether or not there is hydronephrosis. The renal cortex is thick and there is little space in renal calyces in patients without hydronephrosis, making PCNL challenging for urologists with a higher risk of renal bleeding. Other issues after PCNL include sepsis and postoperative fever. Ever occurs in 21-39% of cases, while urosepsis happens in 0.3% to 9.3% of instances, according to a report. A disorder known as urosepsis has a significant fatality rate[3].

Therefore, the goal of this study was to analyze various known postoperative surgical outcomes, including stone clearance, fever, bleeding, and need for blood transfusion, etc., according to the presence of hydronephrosis.

MATERIALS and METHODS

A retrospective study was conducted at Doris Sylvanus General Hospital. Data of the patients was taken from hospital records. All consecutive patients who were candidates for PCNL surgery between August 2020 and August 2022 were enrolled. Patients with kidney stones larger than 2 cm, stones resistant to extracorporal shockwave lithotripsy, and proximal ureteral stones larger than 1.5 cm are treated with PCNL at our facility. Plain abdominal radiography and ultrasonography (USG) with intravenous urography or computed tomography (CT) were performed as pre-operative imaging. Patients with congenital kidney anomalies and uncorrected coagulopathy were excluded. The Research Ethics Committee of Doris Sylvanus General Hospital approved the study (number: 680-1/UM-TU/RSUD/01-2022).

According to Grainger and Allison's Radiology Diagnostics, the following grading system of hydronephrosis is utilized by radiologists/sonographers[4]:

- Grade I: minor calyceal fornices blunting.

- Grade II: calyceal fornices have become enlarged and blunter, but there are still visible papillae silhouettes.

- Grade III: calyces becoming rounded and papillae disappearing.

- Grade IV: severe ballooning of the calyces.

The modified Clavien-Dindo grading system was used for evaluating perioperative and postoperative

complications of PCNL[10]. Classification of surgical complications according to the modified Clavien-Dindo system[11]:

- Grade I: Any deviance from the expected recovery course without the requirement for medication or for surgical, endoscopic, and radiological procedures. Permitted medications include drugs such as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy.

- Grade II: Complications that need pharmaceutical management with medications other than those that were permitted for Grade I complications. Also included are complete parenteral nutrition and blood infusions.

- Grade III: Complications that need surgical, endoscopic, or radiologic procedures.

3a, procedures not under general anesthesia,

3b, procedures under general anesthesia.

- Grade IV: Complications that demand admission to the critical care unit and are life-threatening.

4a, Single organ dysfunction,

4b Multiple organ dysfunction.

- Grade V: The patient passes away.

Technique

The tools used in this study were ureteroscope (Karl Storz), nephrostomy needle no.18 G (Urovision), super-stiff guide wire 0,035 in (Boston Scientific), plastic dilator 6-10 Fr (Urovision), metal dilator 9-30 Fr (Karl Storz), am Platz renal sheath 30 Fr (Boston Scientific), nephroscope 26 Fr (Karl Stroz), pneumatic lithotripsy (Storz, Calcusplit 276300 20) (Figure 1), monitor (Karl Storz) (Figure 2) and USG portable (Mindray, DP-2200) (Figure 3).

After the induction of general or regional anesthesia, cystoscopy is performed and a guidewire is inserted through the ipsilateral ureter. If there is no hydronephrosis, artificial hydronephrosis is made through a ureter catheter[4,10]. Then we turned the endourologist table to place the ipsilateral part of the patient's abdomen. The calyceal puncture was done using a nephrectomy needle no.18 Gauge attached to the ultrasound probe side (Figure 4). After puncturing into the calyceal system and with the urine coming out through the needle, a guidewire was inserted and dilatation was performed from 6 Fr to 30 Fr amplatz renal sheath[10,11]. A rigid nephroscope 26 Fr was used under an am Platz dilator in all cases for visualization and if needed, pneumatic lithotripsy was performed before extraction of the stones. The removal of the stone and any remaining fragments were then determined by nephroscopy and ultrasound. At the end of the procedure, we inserted an ipsilateral Double J stent (DJ stent), 16 or 18 Fr foley catheter, and 16 Fr nephrostomy tube[4].

In the first 24 h the following surgery, all patients received a normal dose of analgesics and antibiotics, followed by on-demand analgesia. A complete blood count was performed the day the following surgery to check for any changes in hematocrit. Kidneys, ureters, bladder X-ray was performed first postoperative day to confirm stone clearance or look for any residual fragments

Figure 1. PCNL instrument set.

PCNL: Percutaneous nephrolithotomy

Figure 2. Monitor.

and DJ stent position[4,5]. Foley catheters were removed on the first postoperative day if hematuria was not evident[5]. In the absence of any complications, nephrostomy tubes were removed and the patients were discharged on the second or third postoperative day[4,5].

Statistical Analysis

Data were researched using SPSS 16.0 (SPSS Inc., Chicago, IL, USA). Data are shown as mean (standard deviation) and number (percentage) based on the type of data. Statistical analysis was conducted using the chi-squre test and correlation analysis (Spearman's rho); $p<0.05$ from the use of 2-side statistical tests was considered statistically significant.

Figure 3. USG portable

USG: Ultrasonography

Figure 4. Puncture with ultrasound-guided

RESULTS

One hundred five patients underwent PCNL with ultrasound-guided in the supine position from August 2020 to December 2021. The baseline demographic characteristics are presented in Table 1, 66 (62.86%) were male and 39 (37.14%) were female. The mean age of the patients was 46.62±9.67 years, while the mean body mass index of the patients was 24.41±3.49 kg/m^2. The location of stones consisted of kidney 86 (81.90%) and ureter proximal 19 (18.10%), while the classification of stones consisted of 69 cases of single stone (65.72%), 10 cases of multiple stones (9.52%), and 26 cases of staghorn stones (24.76%). The side of stones was on the right side 60 (57.14%) and the left side 45 (42.86%). The mean size of the stone diameter was 2.26±1.03 cm. The presence of hydronephrosis was 85 (80.95%), which consisted of Grade I 15 (14.30%), Grade II 25 (23.80%), Grade III

Table 1. Patient demographics and characteristics.

Characteristic	n, % or mean ± SD
Mean age ± SD, year	46.62±9.67
Sex	
Male	66 (62.86%)
Female	39 (37.14%)
BMI ± SD, kg/m^2	24.41±3.49
Stone diameter, cm	2.26±1.03
Stone classification	
Single stone	69 (65.72%)
Multiple stone	10 (9.52%)
Staghorn stone	26 (24.76%)
Stone location	
Kidney	86 (82.86%)
Proximal ureter	18 (17.14%)
Side of stone	
Right	60 (57.14%)
Left	45 (42.85%)
Hydronephrosis	
Grade I	15 (14.30%)
Grade II	25 (23.80%)
Grade III	28 (26.70%)
Grade IV	17 (16.20%)
No hydronephrosis	20 (19.00%)
Pelvicalyceal system access	105 (100%)
Single/stage PCNL	
Single PCNL	81 (77.14%)
Stage PCNL	24 (22.86%)

SD: Standard deviation, BMI: Body mass index, PCNL: Percutaneous nephrolithotomy

28 (26.70%), and Grade IV 17 (16.20%). The absence of hydronephrosis was 20 (19.05%).

The operative outcomes are shown in Table 2. The mean procedure time was 76.10±12.38 minutes. The mean duration of hospital stay was 2.3±0.6 days. The outcome of the stone-free rate in this study was 74 (70.48%), while the patients with residual stones were 31 (29.52%).

The complications were reported after PCNL in Table 3. The modified Clavien-Dindo system was used to classify the complications of the procedure. In our study analysis, complications occurred in 16 patients (15.23%). The Grade I complications of the Clavien-Dindo classification was observed in 4 cases (3.80%) that presented with fever that required antipyretic therapy. Eleven cases (10.47%) presented Clavien-Dindo's Grade II complication that required a transfusion of red blood cell concentrates to improve the hemoglobin level and stabilize the patient. One patient (0.95%) in our study died. Prior to medical records, the patient had coronary heart disease comorbid. We identified 89 (84.76%) patients with no significant complications.

Table 2. Outcome measurements.

Outcomes	n, % or mean ± SD
Stone clearance	
Stone free rate	74 (70.48%)
Residual stone	31 (29.52%)
Duration of hospital stay (SD), day	2.3±0.6
Duration of operation time (SD), minute	76.10±12.38

SD: Standard deviation

Table 3. Classification of surgical complications by the modified Clavien-Dindo system.

The modified Clavien-Dindo system	n=105 (%)
No complication	89 (84.76%)
Grade I	4 (3.80%)
Grade II	11 (10.47%)
Grade V	1 (0.95%)

The statistical result in Table 4 was the relationship between hydronephrosis and the grade of complication using the modified Clavien-Dindo system. We found a p-value of 0.207 (>0.05), and there is no statistically significant relationship with p=0.382 (>0.05) and r=- 0.086 was negative correlation shown in Table 5.

Furthermore, the relationship between hydronephrosis and stone clearance is demonstrated in Table 6. We found a p-value of 0.310 (>0.05). There was no statistically significant relationship between them in the statistical result.

DISCUSSION

Renal stone disease is a common disease in all societies, and its incidence is fairly high. It is important to know the clinical profile and environmental factors of patients with renal stone disease as it is useful in advising people for taking preventive measures for reducing the risk of disease as well as for treating the patient[12]. PCNL is an established and commonly practiced treatment modality for renal calculi. Although PCNL has been accepted as a standard method for treating large renal stones, the incidence of complications is relatively high[13].

In pediatric populations, kidney transplant recipients, and patients with ectopic kidneys, the use of ultrasonographic guiding for antegrade collecting system access before PCNL has been reported to be safe and successful[9,11,12]. There are many benefits to using USG as a guiding modality, including reduced operating time, fewer punctures, and the absence of ionizing radiation[13,14]. It also makes it possible to image the structures that lie between the skin and the kidney. In a study by Osman et al.[15], fluoroscopic conventional prone PCNL with

Table 4. Association hydronephrosis with the complications.

		The complications by the modified Clavien-Dindo system								
		No complication		Grade 1		Grade 2		Grade 5		p-value
		n	%	n	%	n	%	n	%	
Hydronephrosis (HN)	No HN	18	90.0%	2	10%	0	0%	0	0%	**0.207** >0.05
	I	11	73.3%	0	0%	4	26.7%	0	0%	
	II	19	76.0%	2	8.0%	3	12.0%	1	4.0%	
	III	25	89.3%	0	0%	3	10.7%	0	0%	
	IV	16	94.1%	0	0%	1	5.9%	0	0%	
	Total	89	84.8%	4	3.8%	11	10.5%	1	1.0%	n=105; 100%

ultrasound guidance showed no notable complications, and Hosseini et al.[16] have demonstrated that ultrasound-guided PCNL is a good substitute for fluoroscopic technique.

In this series, we describe a fully ultrasound-guided supine PCNL technique we created to benefit from both the supine position and radiation-free treatment. To the best of our knowledge, this is the first report that used ultrasonographic guidance throughout the entire treatment with the patient laying supine. Although PCNL has become the accepted standard of care for the management of large renal stones, complications are still a common occurrence[17]. Therefore, the correlation of preoperative variables with the outcome of PCNL surgery is an important consideration to assess better surgical outcomes.

According to a Korean study by Kim et al.[3], patients undergoing PCNL without hydronephrosis needed longer hospital stays, longer operating times, lower stone clearance rates, and more blood transfusions due to bleeding problems than patients with hydronephrosis did. In research by Yousuf et al.[18], patients with hydronephrosis had postoperative bleeding in 64 patients (40.7%) as opposed to 82 patients (57.3%) without hydronephrosis (p=0.004). However, there was no relationship between the grade of hydronephrosis and stone clearance (p=0.310). This is similar to the study by Satyanarayan et al.[19] that showed p=0.375.

Table 5. Correlation between hydronephrosis with the complications.

The complications by the modified Clavien-Dindo system	
Hydronephrosis	r=-0.086 p=0.382 (>0.05) n=105
Spearman's rho	

Table 6. Correlation between hydronephrosis with stone clearance.

		Stone clearance		
		Residual stone	**Free stone**	
Hydronephrosis (HN)	No HN	18	2	Chi-square test p=0.310 >0.05
	I	10	5	
	II	16	9	
	III	18	10	
	IV	12	5	
	Total	74	31	n=105 (100%)

Significant problems connected to PCNL have been grouped under the modified Clavien-Dindo classification of complications. To develop a new approach centered on the problems following PCNL, de la Rosette et al.[12] employed the well-known Clavien-Dindo classification system. By standardizing the classification of complications, this new classification makes it easier to conduct analysis and better understand the hazards related to PCNL. By classifying each complication into a group with comparable morbidity and mortality statistics, it facilitates comparisons of complications using a more objective pattern. Therefore, to categorize PCNL complications in our investigation, we used the modified Clavien-Dindo classification[11].

A 21.5% rate of problems was found in a review by Taylor et al.[20] that included 5,803 individuals who received PCNL. They reported 2 (0.03%) patients with Clavien-Dindo is Grade V complication. Mortality was linked to complications secondary to pulmonary embolism, acute myocardial infarction, and severe sepsis[20]. It means no direct association between hydronephrosis and death after PCNL surgery. In our study analysis, complications occurred in 16 patients (15.23%). Grade I complications of the Clavien-Dindo classification were of in 4 cases, 11 cases of with Clavien-Dindo Grade II complications, and 1 patient died. Prior to the medical records, the deceased patient had coronary heart disease comorbid.

In our study, there was no relationship between hydronephrosis and the grade of complication using the modified Clavien-Dindo system. Hydronephrosis was not significantly associated with the grade of complications with p=0.382 (>0.05) and r=-0.086 was a negative correlation. Similar to the Indian study by Satyanarayan et al.[19], hydronephrosis was not significantly associated with postoperative fever (p=0.077), which was most probably due to good pre-operative antibiotic coverage. However, Chen et al.[21] have suggested that hydronephrosis may be linked to a higher risk of postoperative infectious complications. Since hydronephrosis is a consequence of defective renal collecting system drainage, it is reasonable to suppose that kidneys with impaired drainage are more susceptible to infection. There is no connection between hydronephrosis and postoperative bleeding according to research by Srivastava et al.[22] (p=0.056). According to Lee et al.[23], there is a substantial correlation between the likelihood of serious bleeding during PCNL and the absence of hydronephrosis (p=0.004). In cases of hydronephrosis, the perioperative bleeding that occurs after PCNL surgery may be caused by aberrant arteries that flow through the hydronephrosis system.

To date, there is a lack of data regarding hydronephrosis as a risk factor for complications after PCNL. Research on the significance of hydronephrosis on surgical outcomes following PCNL remains limited. Since no similar research has ever been conducted before, the findings will help streamline surgical procedures going forward and reduce postoperative problems. It was a single institution-based observational study conducted in a limited time frame. The patients included were those who underwent surgery for renal calculi, representing a subset of the population. To appropriately examine the profile and management outcomes of patients having PCNL for the treatment of renal calculi, further research with larger patient numbers and longer follow-up are required.

CONCLUSION

The preferred therapy for staghorn stones and large kidney stones is PCNL. The use of ultrasonographic guidance PCNL has been reported as a safe and effective procedure. The modified Clavien Grading system is useful for comparison and reporting of complications following PCNL. In this study, we investigated the correlation between hydronephrosis of patients with surgical outcomes after ultrasound-guided supine PCNL and found no correlation and signification.

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Ethics

Ethics Committee Approval: The ethics of this study has been approved by the ethics committee of the Doris Sylvanus Hospital Research Center with Ethical Approval number 680-1/UM-TU/RSUD/01-2022.

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Author Contributions

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REFERENCES

1. Alshoabi SA. Association between grades of Hydronephrosis and detection of urinary stones by ultrasound imaging. Pak J Med Sci. 2018;34:955-8.
2. Amri M, Naouar S, Ben Khalifa B, Hmidi N, Braiek S, ElKamel R. Predictive factors of bleeding and fever after percutaneous nephrolithotomy. Tunis Med. 2019;97:667-74.
3. Kim HY, Choe HS, Lee DS, Yoo JM, Lee SJ. Is Absence of Hydronephrosis a Risk Factor for Bleeding in Conventional Percutaneous Nephrolithotomy. Urol J. 2020;17:8-13.
4. Wang S, Zhang Y, Zhang X, et al. Tract dilation monitored by ultrasound in percutaneous nephrolithotomy: Feasible and safe. World J Urol. 2020;38:1569-76.
5. Zhang B, Xie H, Hu Y, Liu C. The visual percutaneous nephrolithotomy versus the conventional percutaneous nephrolithotomy in treatment for renal stone. Minerva Urol Nefrol. 2019;71:627-35.
6. Gadzhiev N, Malkhasyan V, Akopyan G, Petrov S, Jefferson F, Okhunov Z. Percutaneous nephrolithotomy for staghorn calculi: Troubleshooting and managing complications. Asian J Urol. 2020;7:139-48.
7. Falahatkar R, Shahraki T, Falahatkar S, Esmaeili S, Mashouf P. Evaluating outcomes of complete supine percutaneous nephrolithotomy for staghorn vs multiple non-staghorn renal stones: a 10-year study. World J Urol. 2021;39:3071-7.
8. Levy MM, Evans LE, Rhodes A. The Surviving Sepsis Campaign Bundle: 2018 update. Intensive Care Med. 2018;44:925-8.
9. Wang S, Yuan P, Peng E, et al. Risk factors for urosepsis after minimally invasive percutaneous nephrolithotomy in patients with preoperative urinary tract infection. Biomed Res Int. 2020;2020:1354672.
10. Tefekli A, Ali Karadag M, Tepeler K, et al. Classification of percutaneous nephrolithotomy complications using the modified Clavien grading system: looking for a standard. Eur Urol. 2008;53:184-90.
11. Balaji A, Chellapandian R. Outcome and Complications of PCNL–A Single Centre experience. IOSR Journal of Dental and Medical Sciences. 2018;17:46-50.
12. de la Rosette J, Assimos D, Desai M, et al. The Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study: indications, complications, and outcomes in 5803 patients. J Endourol. 2011;25:11-7.
13. Safarinejad MR. Adult urolithiasis in a populationbased study in Iran: prevalence, incidence, and associated risk factors. Urol Res. 2007;35:73-82.
14. Basiri A, Ziaee SA, Nasseh H, et al. Totally ultrasonography-guided percutaneous nephrolithotomy in the flank position. J Endourol. 2008;22:1453-7.
15. Osman M, Wendt-Nordahl G, Heger K, Michel MS, Alken P, Knoll T. Percutaneous nephrolithotomy with ultrasonography-guided renal access: experience from over 300 cases. BJU Int. 2005;96:875-8.

16. Hosseini MM, Hassanpour A, Farzan R, Yousefi A, Afrasiabi MA. Ultrasonography-guided percutaneous nephrolithotomy. J Endourol. 2009;23:603-7.
17. Francesca F, Felipetto R, Mosca F, Boggi U, Rizzo G, Puccini R. Percutaneous nephrolithotomy of transplanted kidney. J Endourol. 2002;16:225-7.
18. Yousuf F, el Khalid S, Mahmood AW, Iqbal Z, Hassan W, Siddique SHU. Is hydronephrosis a risk factor for complications in conventional percutaneous nephrolithotomy? Professional Med J. 2022;29:110-5.
19. Satyanarayan M, Singh V, Sasidharan S, Tomar L, Dhillon H. Correlation Between Preoperative Variables of The Patients and Management Outcome After PCNL Surgery: An Observation Study. European J Pharm Med Res. 2020;7:403-11.
20. Taylor E, Miller J, Chi T, Stoller ML. Complications associated with percutaneous nephrolithotomy. Transl Androl Urol. 2012;1:223-8.
21. Chen L, Xu QQ, Li JX, Xiong LL, Wang XF, Huang XB. Systemic inflammatory response syndrome after percutaneous nephrolithotomy: an assessment of risk factors. Int J Urol. 2008;15:1025-8.
22. Srivastava A, Singh KJ, Suri A, et al. Vascular complications after percutaneous nephrolithotomy: are there any predictive factors? Urology. 2005;66:38-40.
23. Lee JK, Kim BS, Park YK. Predictive factors for bleeding during percutaneous nephrolithotomy. Korean J Urol. 2013;54:448-53.